The ATLAS Experiment at CERN

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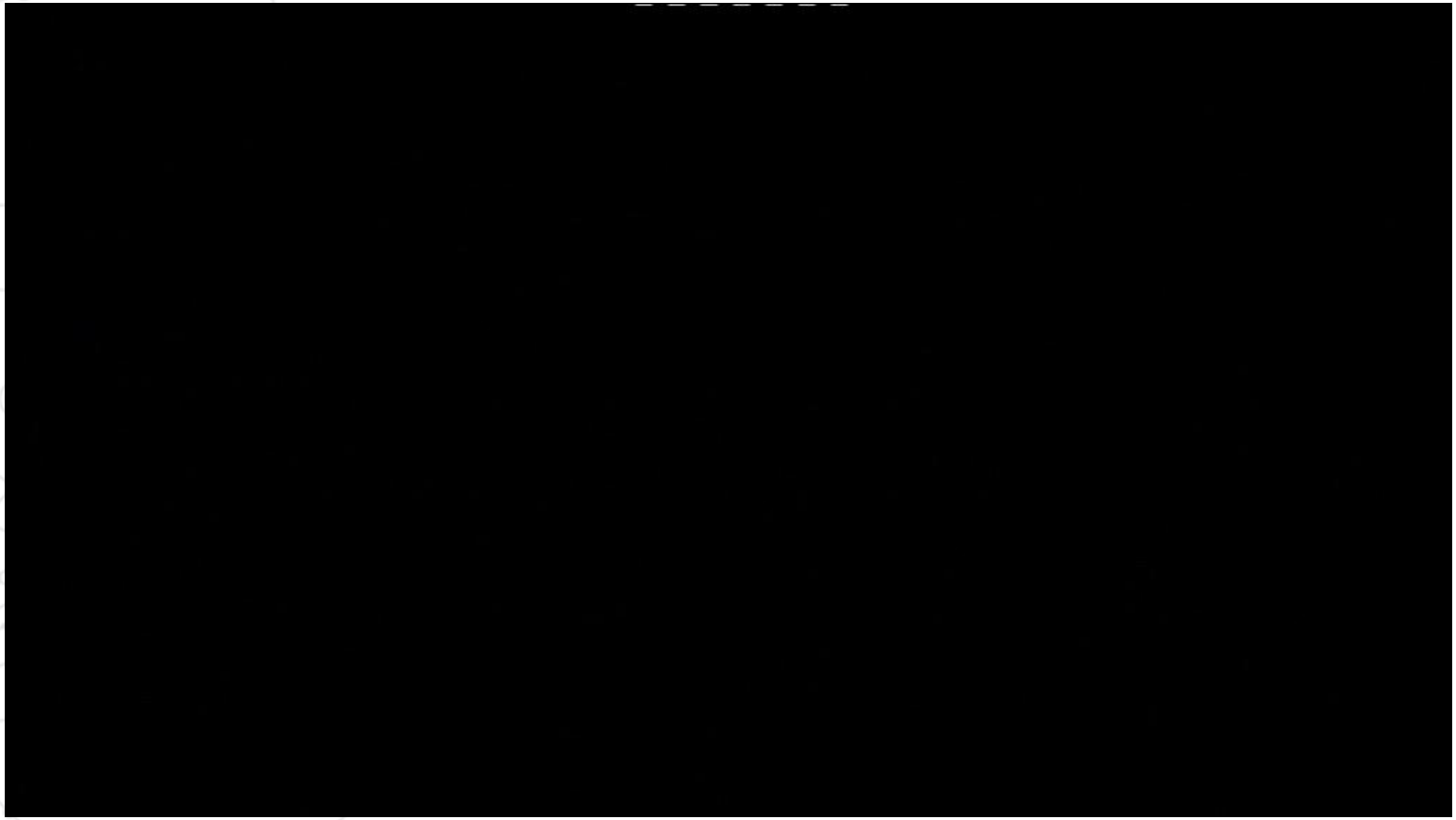
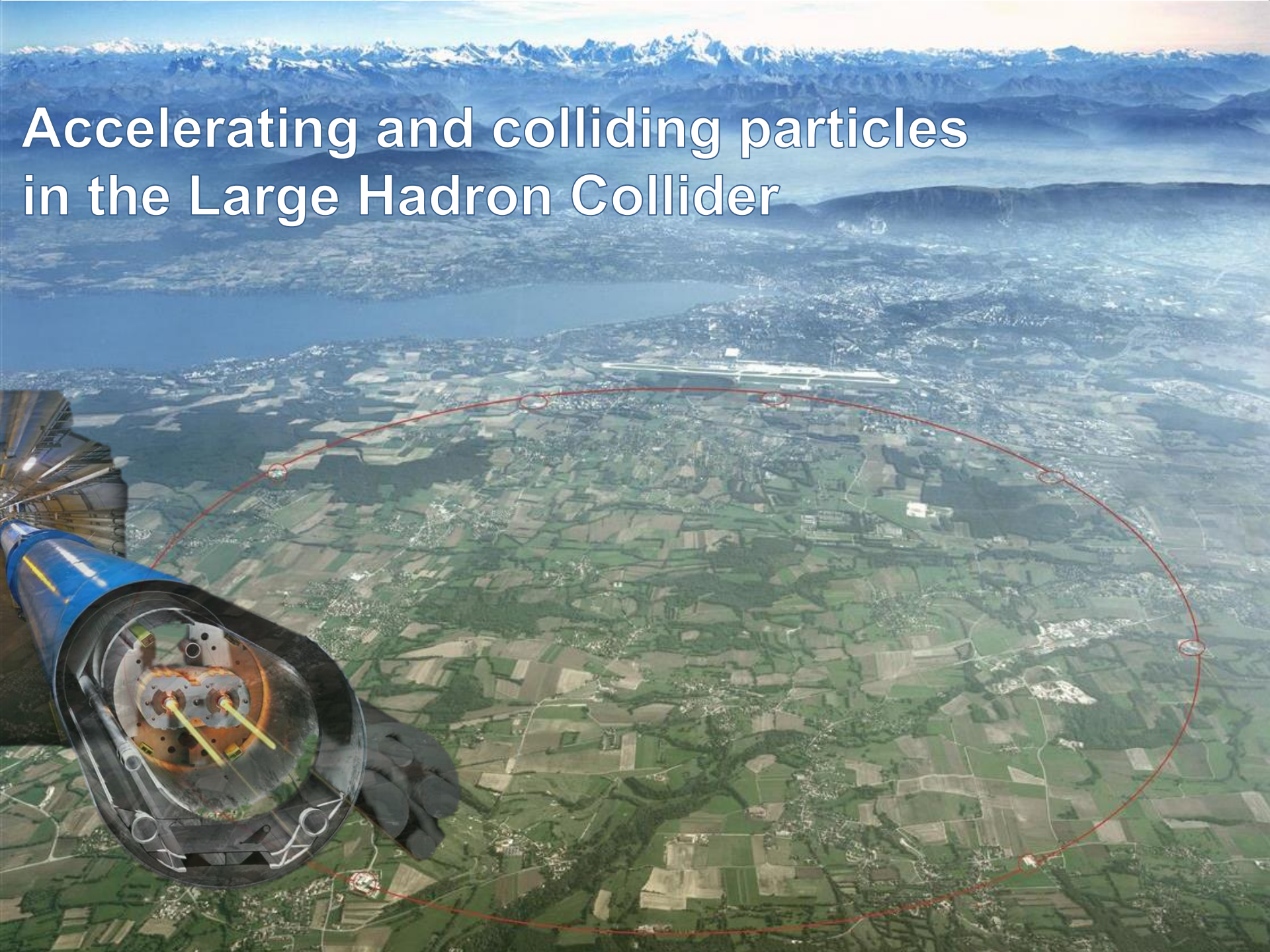
Angels & Demons

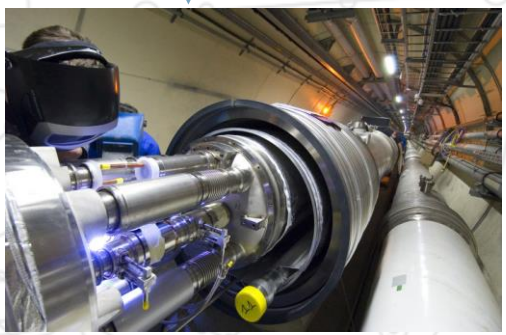


The Large Hadron Collider

Accelerating and colliding particles in the Large Hadron Collider



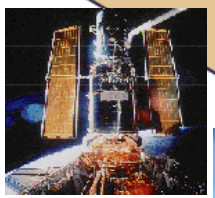
The super-microscope

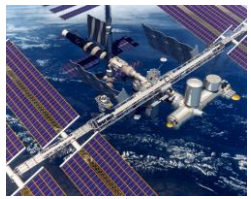


LHC

Big Bang
Proton
Atom
Radius of Earth
Earth to Sun
Radius of Galaxies
Universe

10^{-32} 10^{-28} 10^{-24} 10^{-20} 10^{-16} 10^{-12} 10^{-8} 10^{-4} 10^{4} 10^{8} 10^{12} 10^{16} 10^{20} 10^{24} 10^{28} cm





Study physics laws of first moments after the big bang increasing symbiosis between particle physics, astrophysics and cosmology

The LHC numbers

The tunnel's circumference is **27 km**.

Particles are accelerated to the **99.9999991%** of the speed of light.

Superconductors cooled down to **1.9 K**.

12000 A to produce magnetic field to guide the protons.

The vacuum is cleaner than the interplanetary space.

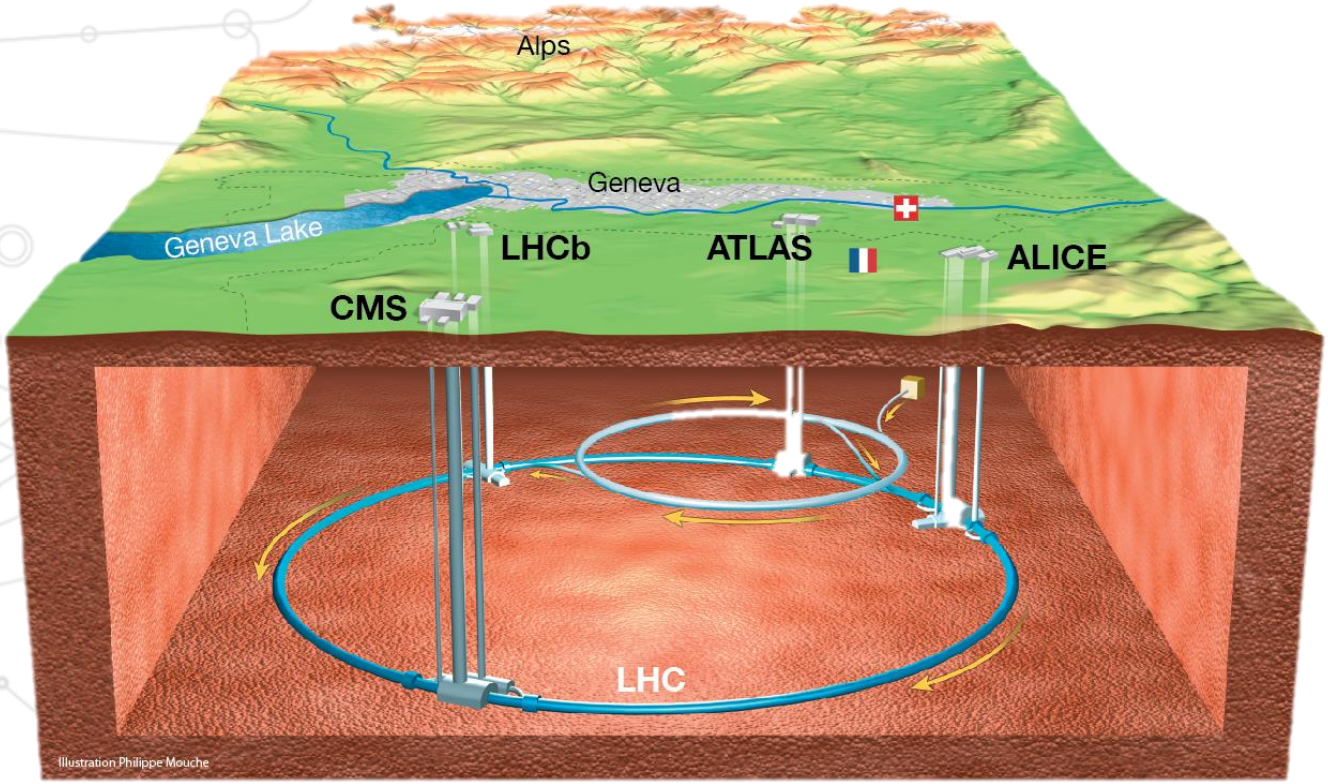
Particle bunches collide every **25 ns**.

Particle detectors

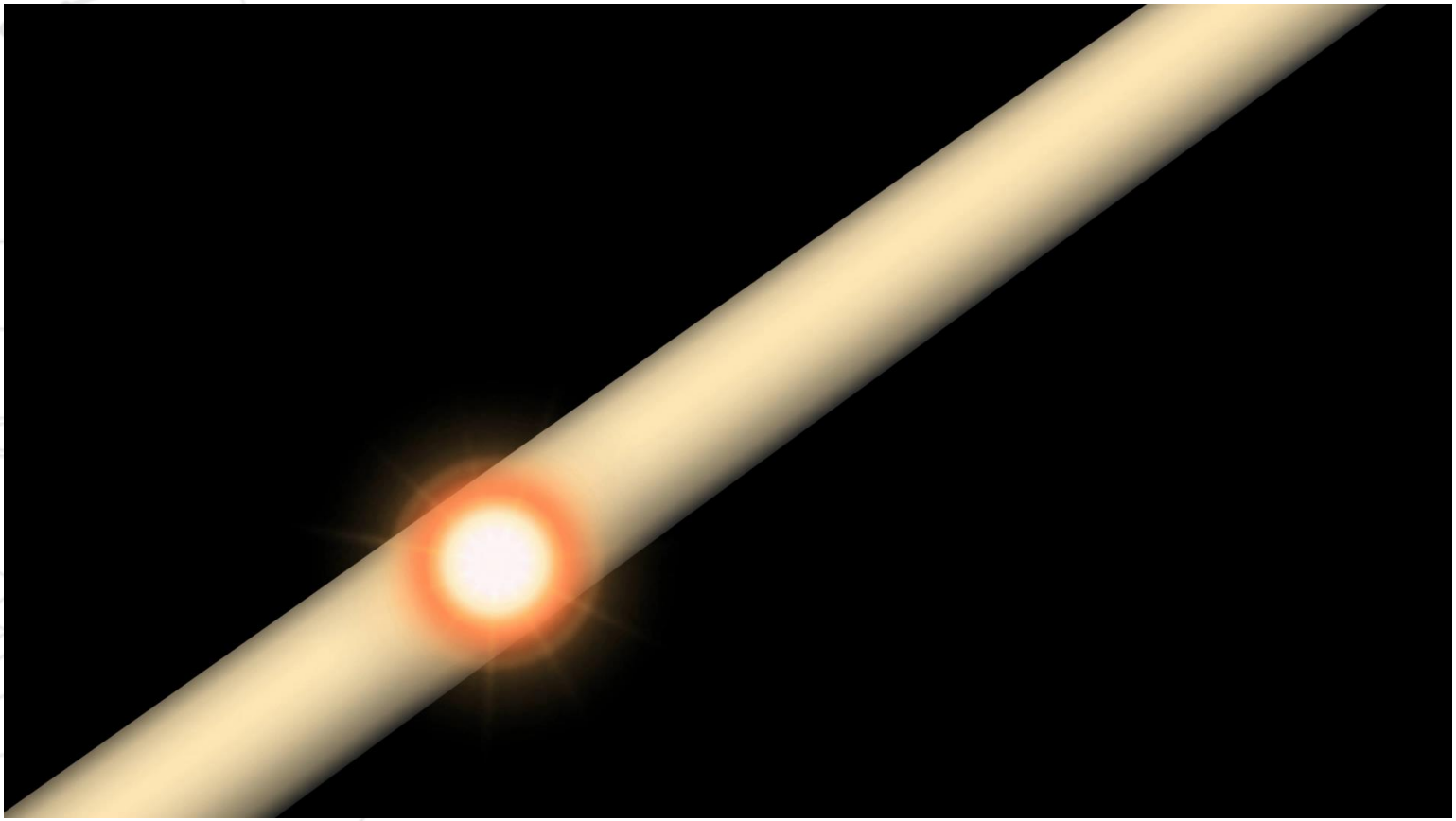
Huge “cameras” take “pictures” of the collisions each **25 ns**.

~10^7 channels

400 Tb/s of data assuming binary channels.



Particle collisions



The ATLAS experiment

The largest of the detectors

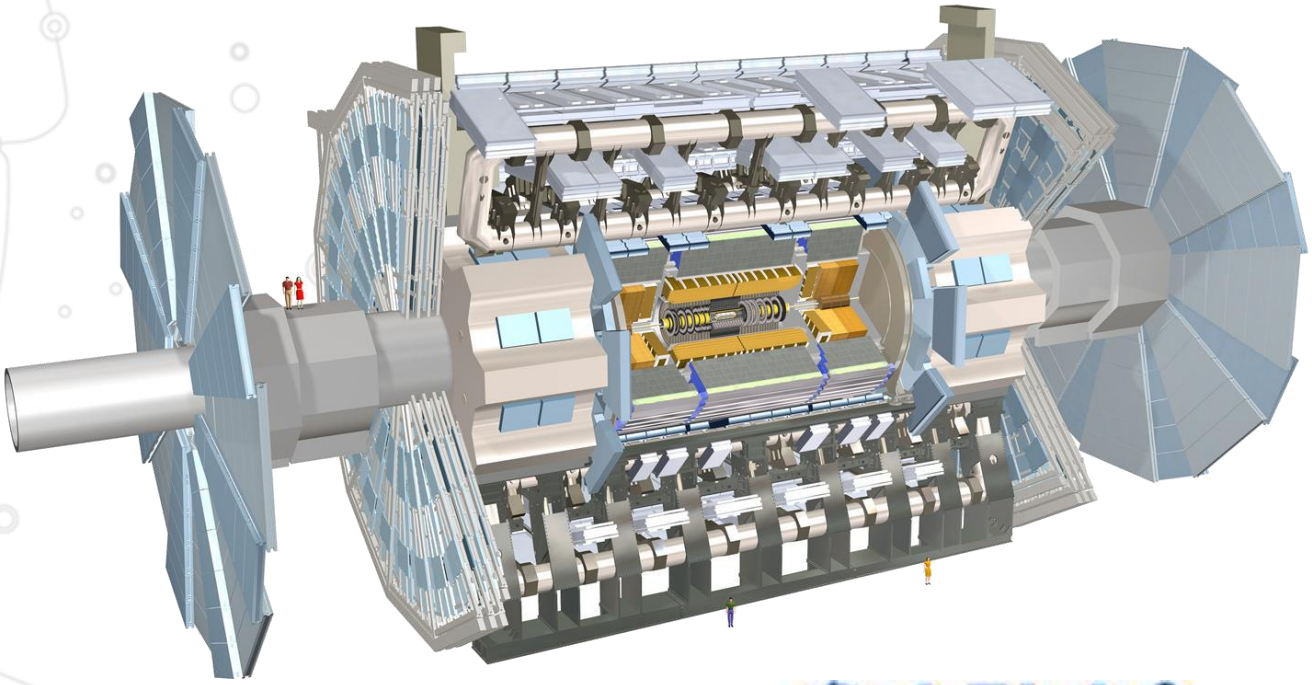
Diameter: **25 m**

Length: **46 m**

Cables: ~**3000 km**

Overall weight: **7000 tonnes**

Electronic channels: **~100 million**



The particles from a collision event leave tracks and deposit energy in the detector.

ATLAS EXPERIMENT

Look for discoveries that the Standard Model cannot explain

Why the matter of the Universe is dominated by the dark matter?

Why the amounts of matter and antimatter are not equal?

New forces and unification of forces

Possible unknowns?

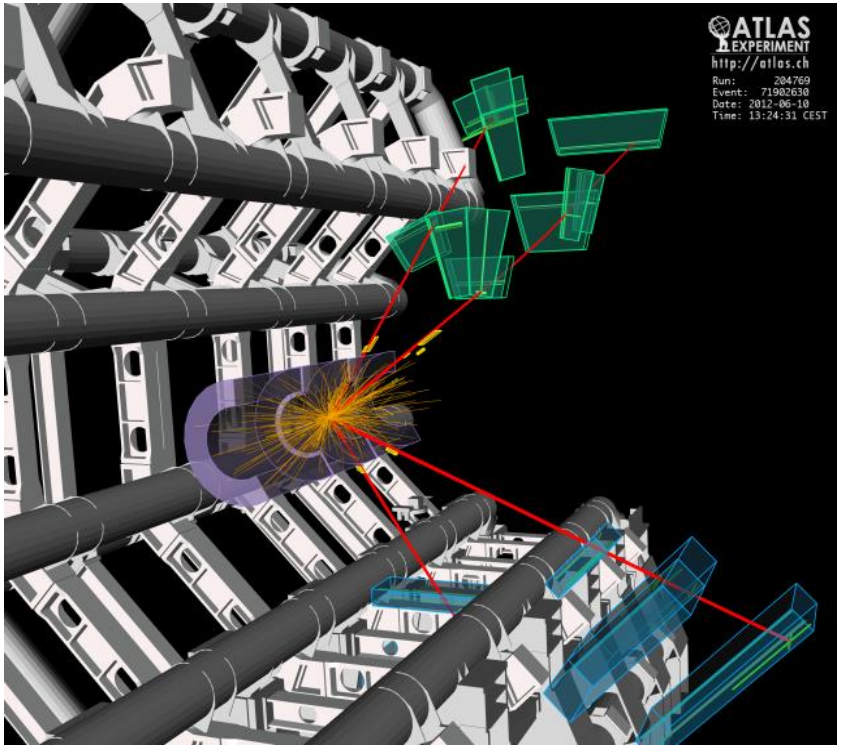
- Extra dimensions of space
- Microscopic black holes
- String theory

The Standard Model

- Discovery of the Higgs boson in 2012

Discovery of a new particle

In the Standard Model, all particles get their masses from the Higgs field.



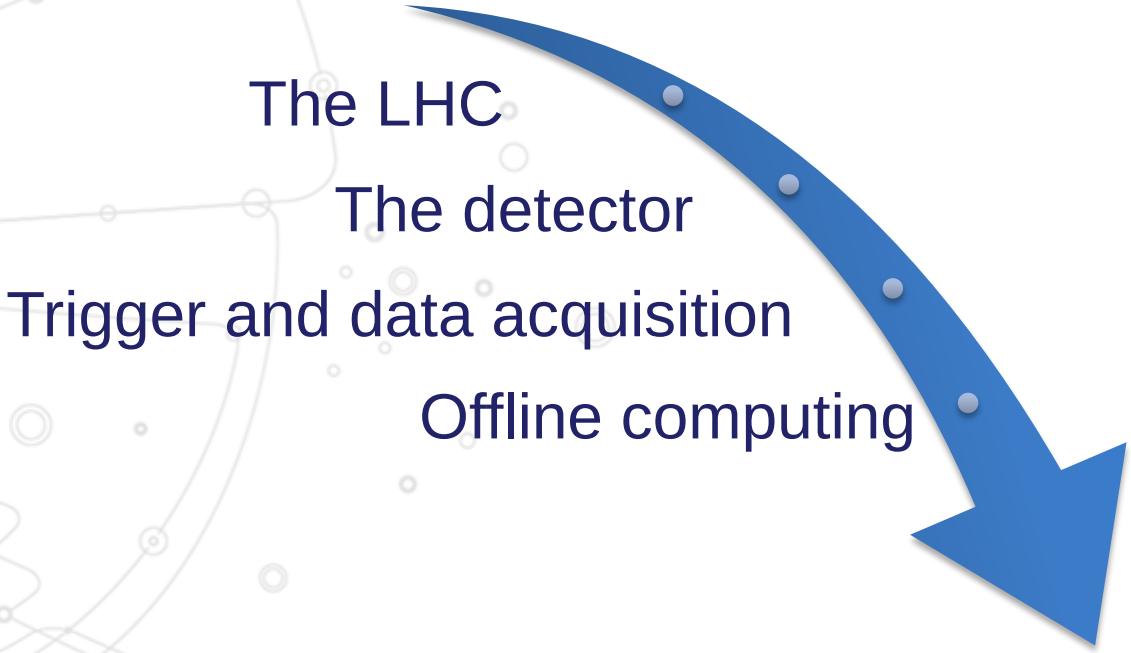
4 July 2012

ATLAS and CMS announced they had each observed a new particle which is consistent with the Higgs boson.

8 October 2013

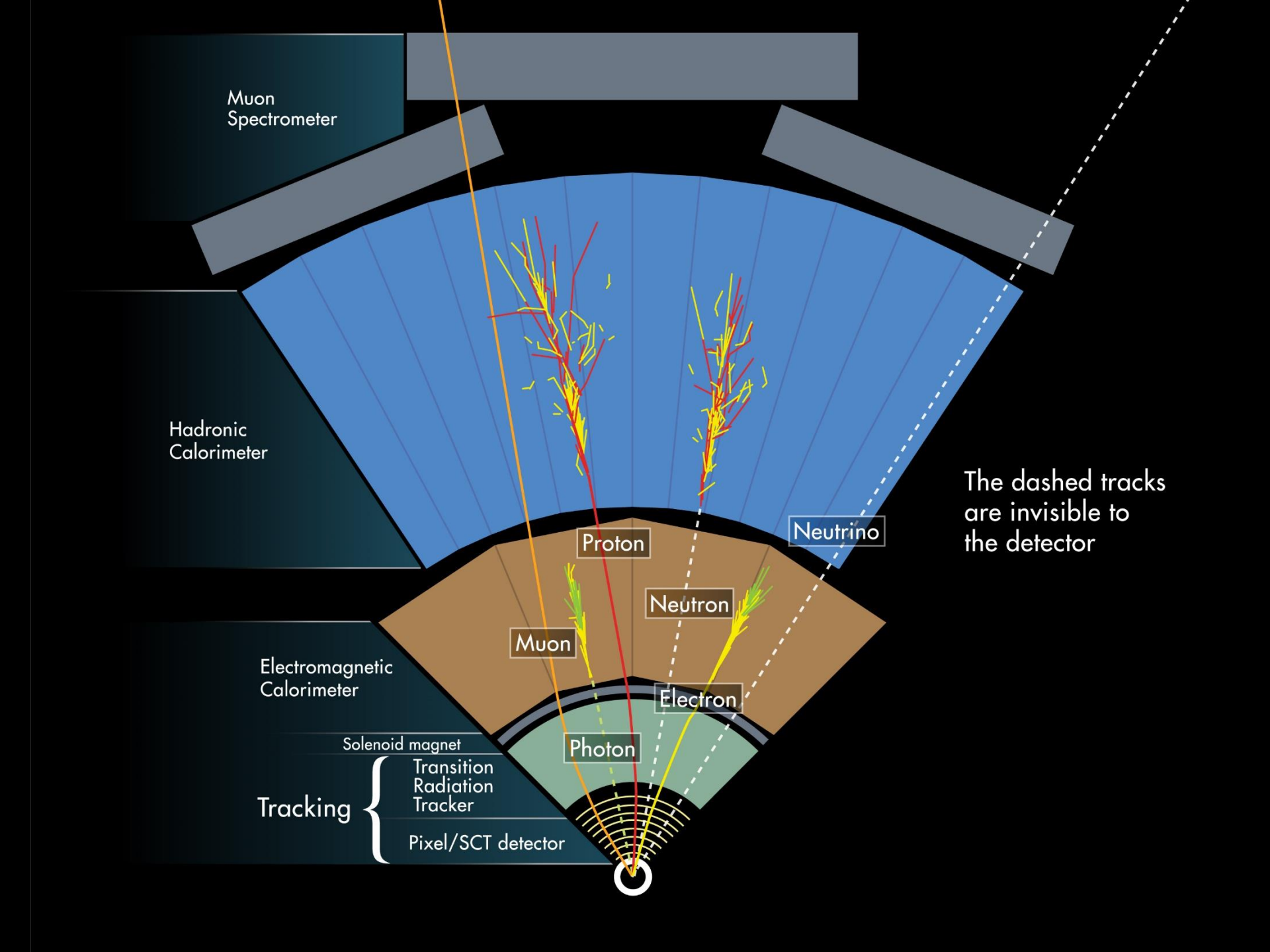
The Nobel prize in physics awarded jointly to F. Englert and P. Higgs for their work on the theory of the Higgs boson.

Technical challenges

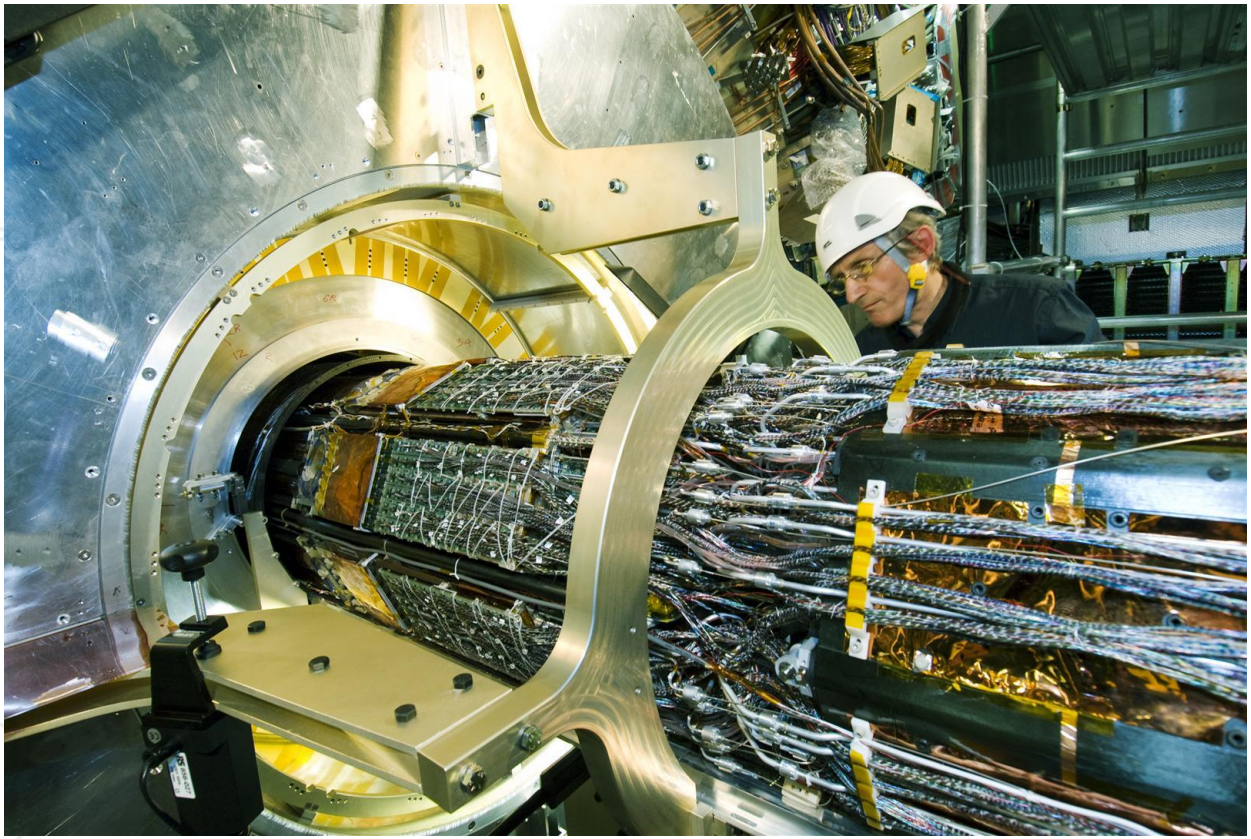


Technology transfer

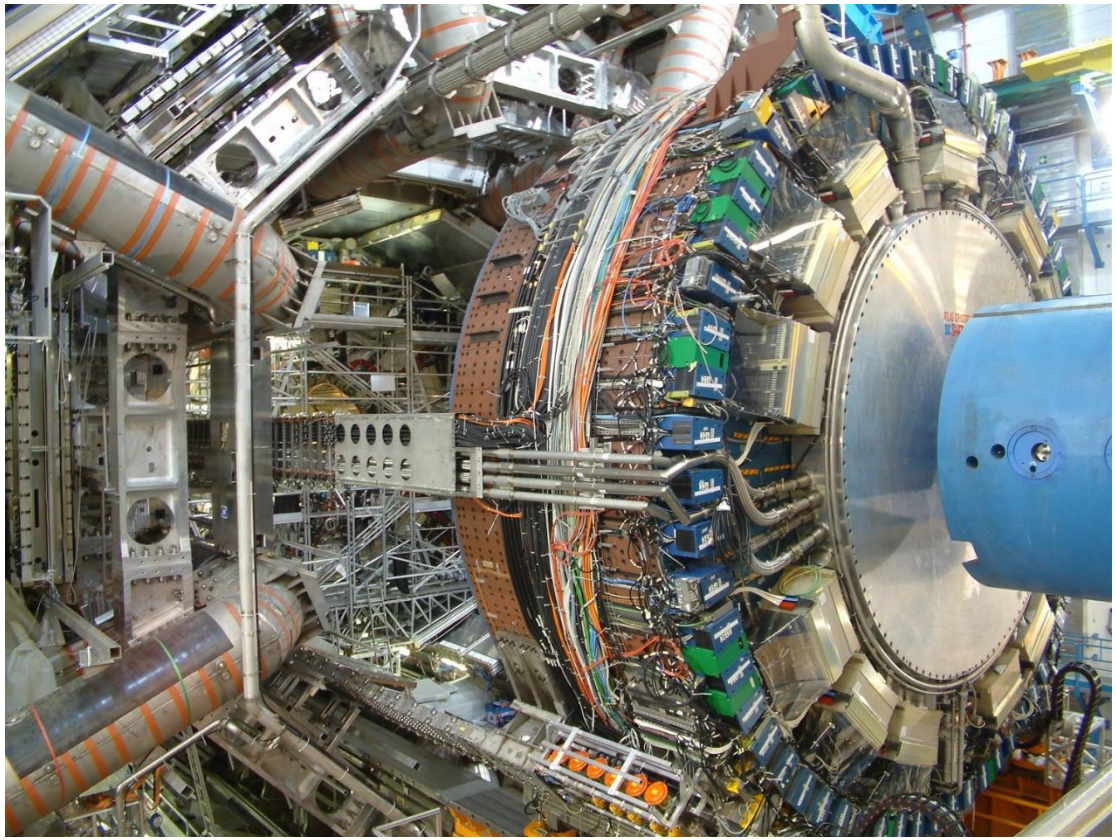
Major components of the ATLAS detector


Muon
Spectrometer
Hadronic
Calorimeter
Electromagnetic
Calorimeter
Solenoid magnet
Tracking
Transition
Radiation
Tracker
Pixel/SCT detector
Proton
Neutrino
Neutron
Muon
Electron
Photon
The dashed tracks
are invisible to
the detector

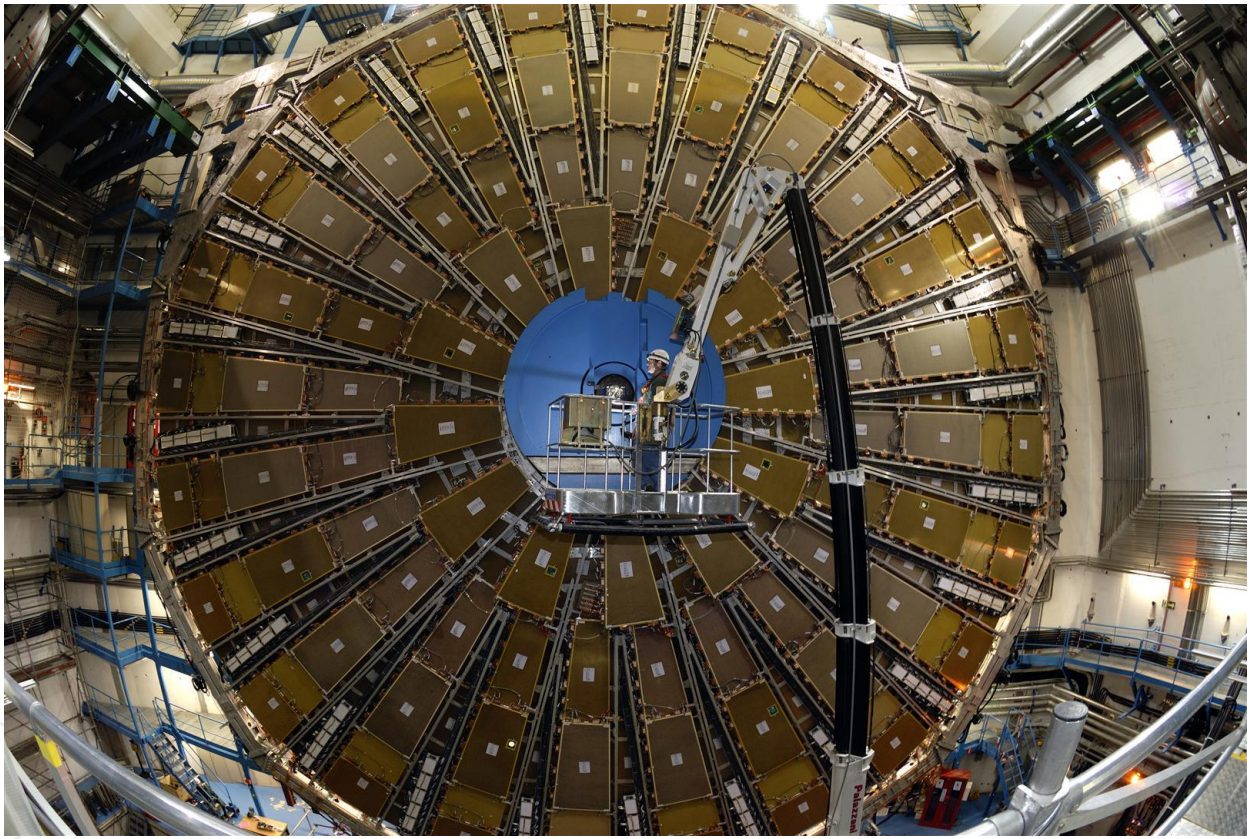
The inner detector measures the tracks of charged particles



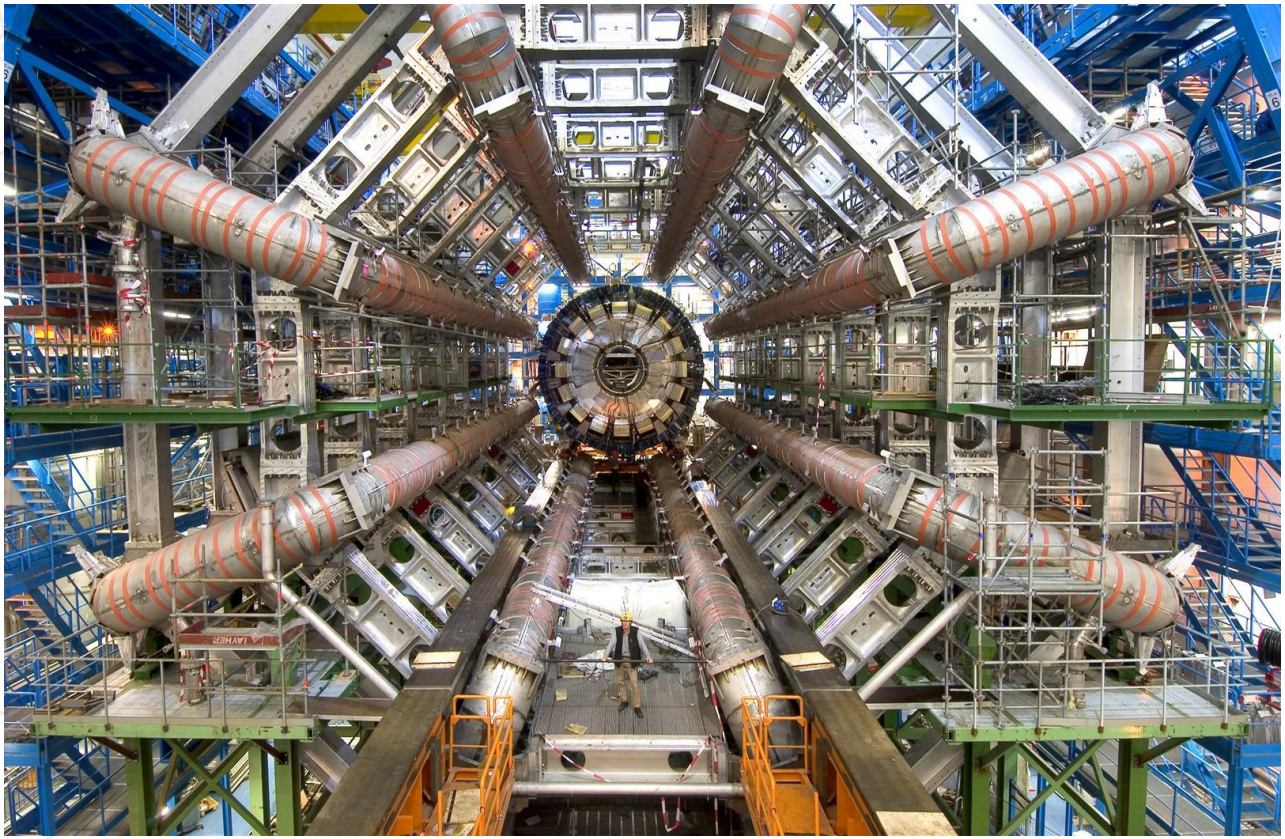
The calorimeters absorb and measure the energies carried by the particles



The muon spectrometer identifies and measures the momenta of muons



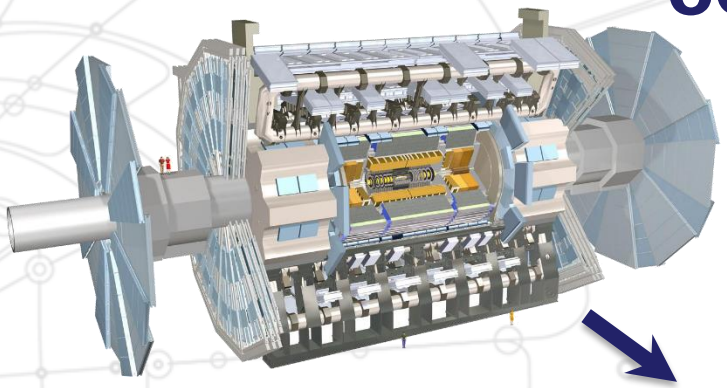
The magnet system bends charged particles for momentum measurement



Trigger and data acquisition

The TDAQ system

Reconstruct, analyse and select complex events in real time



640 Tbps

ADC

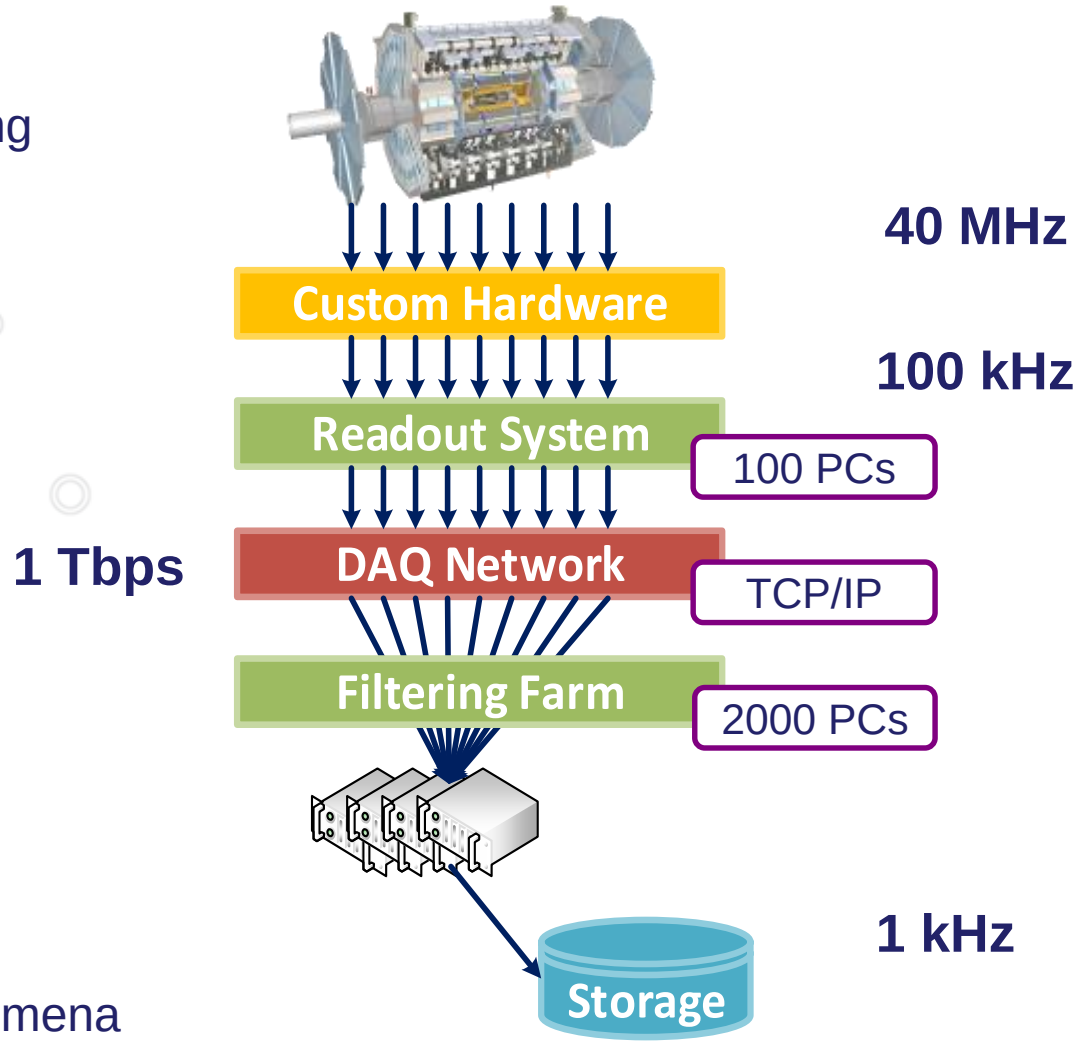
Processing

Storage

What can be done with commodity hardware?

Data flow in the ATLAS experiment

Total single event size: 2 MB
50% required on average for filtering



Searching for extremely rare phenomena

Offline computing
Worldwide LHC Computing Grid

Event reconstruction, simulation and analysis

157 computing centers

40 countries

200 petabytes of disk storage

300 000 processing cores

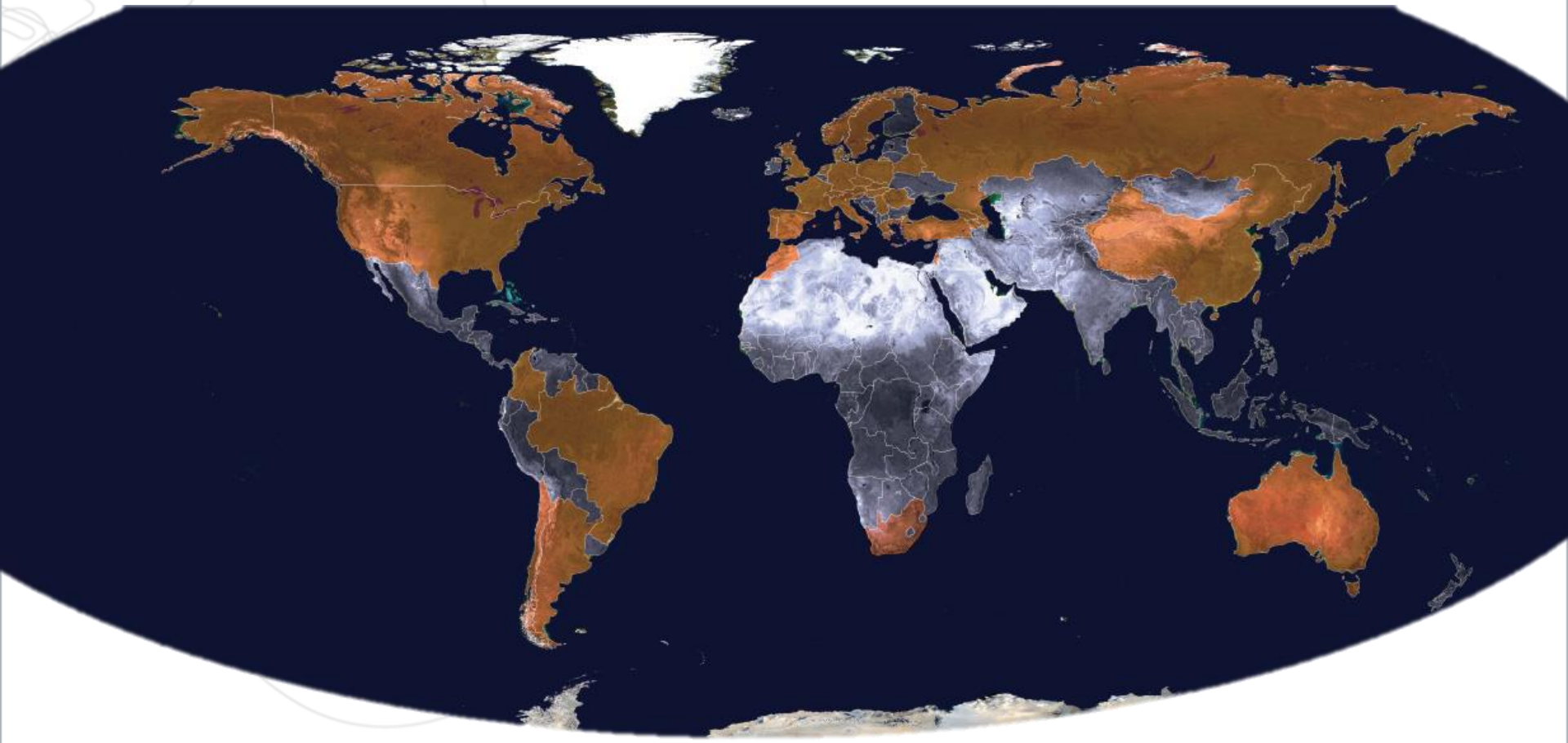
25 petabytes per year

70 petabytes stored at CERN

Background image: Shutterstock

The world of ATLAS

The ATLAS experiment was built by a collaboration of scientists at institutions around the world



Opportunities for students and graduates

Technical Student Programme
Technical training period or final project
4 to 12 months

CERN openlab Student Programme
Advanced IT projects
2 months in summer

Summer Student Programme
8 to 13 weeks

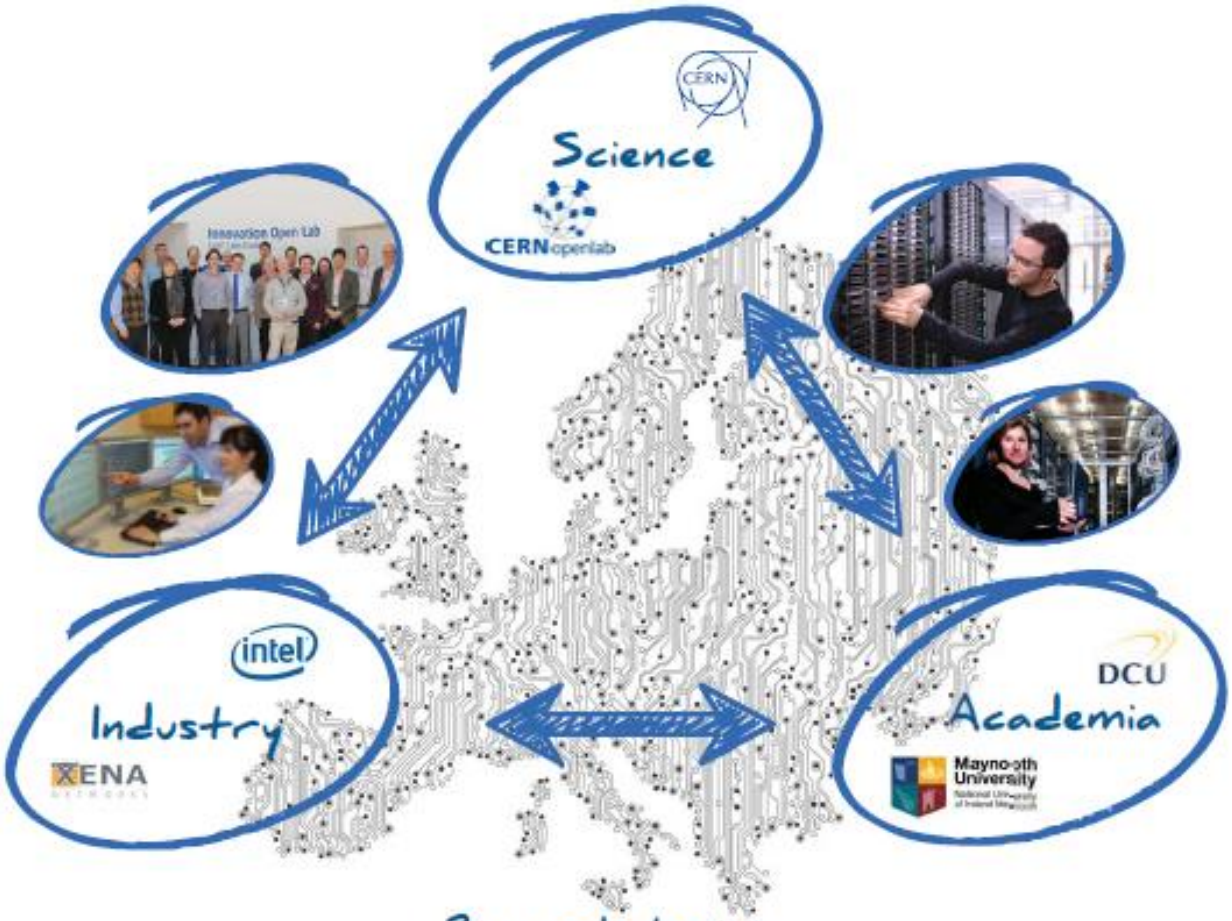
Fellowship Programmes
24 months (Marie Curie – 36 months)

Technician Training Experience (TTE)
1 to 2 years

VIA (Volontaires Internationaux en Administration)
Contract from 6 to 24 months

ICE-DIP 2013-2017:
The Intel-CERN European Doctorate Industrial Program

A public-private partnership to research solutions for next generation data acquisition networks, offering research training to five Early Stage Researchers in ICT



Research topics:

- Silicon photonics systems
- Next generation data acquisition networks
- High speed configurable logic
- Computing solutions for high performance data filtering

Background image: Shutterstock

From particle collisions to the computing grid

Questions?